MARKET FOR PH.D.'s IN ENGINEERING AND THE CONTRIBUTION OF FOREIGN PH.D.'s TO RESEARCH PRODUCTIVITY IN TURKEY

by

JORJ TERZİOĞLU

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APPROVED BY

Associate Prof. Abdurrahman Aydemir
(Thesis Supervisor)

Assistant Prof. Fırat İnceoğlu

Assistant Prof. Özge Kemahlıoğlu

DATE OF APPROVAL: ……

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Jorj Terzioğlu

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Supervisor: Abdurrahman Aydemir

ABSTRACT

The main aim of this paper is to study the consequences of the infamous Brain Drain in Turkey in graduate education context. Following the recent literature which centers on the positive outcomes of the emigration of skilled personnel from a developing country, we investigate the possibility of a Beneficial Brain Drain through academic scholars which have obtained their doctoral degrees abroad and returned to Turkey upon completion of their study. With a rich dataset, we first present a detailed overview of the current Ph.D. Market in the engineering faculties of Turkish universities. Second, we conduct estimations to explore the determinants of academic research in Turkey. Along with others, we mainly look upon the relationship between higher education obtained abroad and academic research productivity. Moreover, we also investigate the so-called *spillover effect* of foreign education on research among scholars with a doctoral degree from Turkey. The results show that foreign Ph.D. shares indeed have a positive correlation with academic research conducted in Turkish universities, both on quantity and quality aspects.

Keywords: Brain Drain, Beneficial Brain Drain, Research Productivity

TÜRKİYE'DE MÜHENDİSLİK BİLİMLERİNDEKİ DOKTORA SONRASI AKADEMİK PİYASA VE YABANCI DOKTORALILARIN ARAŞTIRMA ÜRETKENLİĞİNE ETKİSİ

Jorj Terzioğlu

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ÖZET

Bu makalenin amacı, Türkiye'deki yüksek öğrenim temelli Beyin Göçü'nün sonuçlarını incelemektir. Yüksek eğitimli bireylerin yurtdışına gitmelerinin gönderen ülke için pozitif sonuçlarını değerlendiren literatürü takip ederek, bu çalışmada Türkiye için "yararlı beyin göçü" olasılığı araştırılmıştır. Zengin bir veri seti ile ilk olarak Türkiye'deki üniversitelerin mühendislik fakültelerindeki doktora piyasası incelenmiştir. Daha sonra da akademik araştırmaları etkileyen faktörleri araştırmak amacıyla regresyon analizleri yapılmıştır. Kontrol edilen diğer unsurlarla beraber, özellikle Türk üniversitelerindeki yurtdışından doktora almış öğretim görevlisi oranlarının üniversitelerde gerçekleştirilen araştırmalara etkisi ölçülmüştür. Ayrıca, veri setini doktorasını Türkiye'den almış öğretim görevlilierine indirgeyerek, eğitimlerini yabancı ülkelerden alanların, derecelerini yerel bir üniversiteden almış olanlar üzerine akademik araştırma anlamında pozitif bir etkisi olup olmadığı incelenmiştir. Sonuç olarak, yurtdışından doktora almış öğretim görevlisi oranlarının Türk üniversitelerinde gerçekleştirilen araştırmalar ile hem miktar hem de kalite bazında pozitif bir korelasyonda olduğu bulunmuştur.

Anahtar Kelimeler: Beyin Göçü, Yararlı Beyin Göçü, Araştırma Üretkenliği

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1 Introduction

Brain Drain refers to the emigration of educated and skilled professionals from developing countries to developed countries in search of better employment and education opportunities. Millions of people leave their home country and migrate to a more developed nation in order to have better employment or obtain higher education, which leaves the source country having to deal with severe consequences. In Turkey, the phenomenon of a harmful brain migration is not new, either. Along with others such as the large amounts of unskilled workers who have migrated to Germany in 1960's and now reside there; emigration of the high-educated from Turkey, especially to United States and Europe, has long been both a source of attention and a major concern.

This paper aims to study the consequences of the infamous brain drain in Turkey in graduate education context and investigate whether emigration of students has a positive impact in academic research conducted in Turkish universities upon their return.

The phenomenon of Brain Drain has attracted large interest by economists in the literature. It was argued that Brain Drain has severe negative impacts on the source country in terms of productivity, employment and growth, along other dimensions. On their seminal paper, for instance, Bhagwati and Hamada (1974) find that emigration of skilled individuals would lead to a significant loss of tax income in the host country since educated personnel are likely to pay higher taxes if they were to stay in their home country. Miyagiwa (1991), focusing on the scope of the welfare of the people that are left in the source country, argues that it is the "professionals possessing intermediate-level abilities who are hurt by brain drain, regardless of whether they choose to stay or emigrate."

Following the arguments of Lucas on the effect of human capital on economic growth[1], Haque and Kim (1995) in their study assert that the brain drain has negative consequences when the loss of educated personnel reduces the growth of human capital in the source country which leads to a slow down in growth. Kwok and Leland (1982) follow a different perspective and focus on the causes of brain drain rather than its consequences. They find that the imperfect information of employers in the source country on the ability and skills of the highly-educated leads to lesser incentives for professionals abroad to return, thereby extending the effects of brain drain. In sum, although admitting its advantages on increasing

[1] For his seminal paper, see: Lucas (1998).

human capital formation for the migrants, these studies mainly argue that brain drain has severe negative effects on economic growth.

However, more recent literature has challenged this view and it is argued that brain drain can actually lead to positive outcomes for the source country. Namely beneficial brain drain (or brain gain), these arguments claim that emigration of educated personnel may boost economic growth. Accordingly, some authors have looked upon on government policies to implement an optimum level of emigration in order to maximize the host country's welfare.

Several arguments have been presented for the source country to benefit from the migration of educated personnel. First, is the positive effect of brain drain on human capital formation in the sending country. Mountford (1997) argues that the human capital will increase since returns to education are higher and these beneficial effects will outweigh the consequences of brain drain itself. Such an approach treats emigration as uncertain and therefore concludes that the *possibility* of employment abroad raises human capital formation incentives in the source country, even if the migration never occurs in the end.[2] Beine et al. (2001) follow this argument and present supporting empirical evidence.

Second, the existence of remittances sent by the emigrants to their home country is considered to be a possible driving factor for promoting economic growth. Cinar and Docquier (2004) develop a model where education decisions in home country are subject to liquidity constraints and find that a beneficial brain drain is possible when remittances enable home country citizens to overcome this liquidity constraint. Cox (2003) focuses on El Salvador and finds that remittances lead to higher schooling attendances in El Salvador especially among families in poor and rural areas.

Last set of arguments in line with the beneficial brain drain is the phenomenon of return migration.[3] This point of view argues that a brain drain affects the source economy beneficially if the migrated workers return to their home country and transfer their knowledge among others. Dos Santos and Postel-Vinay (2003), for example, argue that migrants contribute to a transfer of better knowledge and technology when they return to their home country and thus creating a potential source for growth.

In the context of Turkey, there are a number of studies in this field. Güngör and Tansel (2008) investigate the determinants of the return intentions of Turkish professionals abroad. Based on an internet survey, their findings assert that return intentions are linked with initial plans and decreases with stay duration abroad. Moreover, they find that specialized training

[2] For a similar work, also see: Vidal(1998).
[3] For a detailed literature review, see Docquier (2006).

abroad, along with other factors, makes return difficult since work opportunities in migrants' area of specialization appears to be lacking in Turkey. Kirdar (2005) examines the return intentions of Turkish workers in Germany and find that immigrants with a higher savings potential are more likely to return. In a similar base, Dustmann and Kirchkamp (2001) studies the activity choices of immigrants when they leave Germany to return to Turkey and find that half of the surveyed individuals have chosen to start up their own businesses as entrepreneurs.

Since this study puts scholars and their academic performance under its scope, it is also mainly related to the research productivity literature. Academic research has attracted much attention by economists and its determinants have long been investigated both in theoretical and empirical grounds. First and foremost, age is considered to be one of the key determinants to academic research. In line with the life-cycle hypothesis which basically states that productivity declines with age, numerous studies have looked upon the effect of a scholar's age - and presumably her experience in the field - on her academic performance. The main arguments regarding the subject are that Ph.D.'s start getting engaged in non-research activities over years such as professional consultancy or administrative duties, as well as the fact that they are not able to keep up with the newest developments in their specialized areas and thus failing to produce.

On empirical grounds, Diamond (1986) discovers that among mathematicians and scientists, research output with respect to quantity and quality declines continuously with age. Levin and Stephan (1991), in their study consisting of six sub-fields in physics, find that in five of the six areas they studied, life-cycle effects exist and research productivity indeed decreases over years. In a recent study, Rauber and Ursprung (2007) investigate the life-cycle pattern among German academic economists and find that research performance follows a hump-shape. Research productivity of German economists tends to reach a peak around at the eighth year of their career and then decline.

Regarding the other determinants of academic research discussed in the economics literature, many authors relate Ph.D. affiliations to productivity. Kocher and Sutter (2001), for example, in their study of U.S. universities, uncover that the university which the scholar has received her highest degree plays a more important role in her academic performance than her current employment.[4] For the country specific works; Guimarães (2002) with his study for Portuguese universities which concludes that there is no significant difference in research productivity between a degree from a foreign country or a Portuguese university, Fabel et al.

[4] For a similar work on the doctoral origins of economics doctorates, see Pieper and Willis (1999).

(2008) which, in contrast, note that Foreign Ph.D.'s are more productive than domestic Ph.D.'s in German, Swiss and Austrian universities, could be mentioned.

Some others have also looked upon the impact of different factors on academic research. For instance, Taylor et al. (2006) and Maske et al. (2003) investigate the negative effects of teaching load on academic research. Also, funding is considered to be of some importance in Jacob and Lefgren (2007).[5]

The main purpose of this study is to explore the possibility of a beneficial brain drain in Turkey in academia framework. Large numbers of students leave Turkey to pursue higher education abroad and some of them decide to return upon receiving their Ph.D. We, in turn, investigate whether the doctoral degrees obtained in foreign countries have a positive effect on academic research productivity, following emigrant students' return and beginning of their employment in Turkish universities.

Along with other factors, we mainly look upon the relationship between foreign higher education and academic research. Moreover, we also investigate the so-called *spillover effect* on research among scholars with a doctoral degree from Turkey. We study the likelihood of an increased academic performance among domestic Ph.D.'s with the presence of foreign ones.

To our knowledge, the characteristics of the Ph.D. market in Turkey have not been studied thoroughly until now. Accordingly, this paper also contributes to the existing literature in two other ways. First, it presents detailed descriptive analysis of the Ph.D. Market in engineering faculties among Turkish universities. With a rich dataset, we are able to describe the current situation of the Ph.D. Market in Engineering. We believe that this analysis partially overcomes the lack of studies of this sort in descriptive nature. Second, the present paper also offers primary evidence on the determinants of academic research productivity in Turkey. Using data on academic publications from engineering faculties, we present results on the academic performance of Turkish universities and underlying factors beneath it.

The rest of the paper is organized as follows: In Section 2, we explain the sources and methodology of our data collection. In Section 3, we present a comprehensive descriptive analysis of the current Ph.D. market in engineering faculties in Turkish universities. Section 4 is devoted to the results of the regression analyses on the determinants of research

[5] For a comprehensive work which also includes a review on the main findings in the field of research productivity, see also: Gonzaled-Brambila and Veloso (2007).

productivity. Finally, in Section 5, we conclude the paper with remarks and comments on future research.

2 Data

The dataset we used throughout this study mainly consists of two parts: Educational background of academic staff in Turkey as of September 2009 and publications in the year 2008. In this section, we explain our sources and methodology for constructing our large dataset.

2.1 Academic Staff

To construct the academic staff data, we first collected educational background information of the scholars in all of the engineering faculties in Turkish universities, as of September 2009. Parts of collected data of a given staff are as follows: name and surname; university, country and year that the Ph.D. was obtained. Second, we also gathered work experience information of a given staff after receiving Ph.D.: name of the universities worked, duration and the title (Assistant Professor, Associate Professor or Professor) during the period of employment.

The list of universities was taken from Milli Eğitim Bakanlığı (MEB) website[6]. We limited our university sample to the universities that were founded before 2006. We were also able to collect information on universities' foundation years and their *types* - either a public university or a private one. We consider the distinction between universities' types with this regard to be crucial in our research since the existence of private universities are of great significance in Turkey's higher educational system, in many aspects. Lastly, our data also possess information on the number of students enrolled in engineering faculties. As mentioned in Section 1, teaching load of a scholar is one of the important determinants of research productivity. In order to use in our regression analysis for determining its impact on academic productivity, we acquired the total number of undergraduate and graduate students in engineering faculties for each university. This data were collected from ÖSYM (Öğrenci Seçme ve Yerleştirme Kurumu)[7] and MEB internet sites.[8]

[6] http://yogm.meb.gov.tr/universiteler.htm
[7] http://osym.gov.tr
[8] http://yogm.meb.gov.tr/universiteler.htm

Our main source for academic staff data was the universities' internet websites, whenever available. We logged on to the official web pages of universities and collected information on academic staff. Educational and work experience pieces of information were collected for every member of the academic staff.

Given the great magnitude, we had some difficulties in obtaining the required relevant information. Our main limitation was the variation in quality of university websites: a large number of universities had missing or inconsistent information about their academic staff - especially in terms of past working experiences - while some of them did not have a properly working web page for some of their engineering departments.

After several consecutive scans on university websites to collect data on academic staff, we have turned to Yüksek Öğretim Kurulu (YÖK)'s academic theses website[9], to complete missing data as much as possible. This website aims to provide all the masters and doctoral theses submitted in Turkey over a long period of time. We used YÖK's website as an additional source for collecting the relevant information on the university and year of the obtained Ph.D. from the submitted doctoral thesis database.

For the faculties, we included all of the typical engineering departments present in Turkish universities. In some of the universities in Turkey, there exist departments with exclusive names that can presumably be listed under more conventional department categories.[10] In sum, our dataset includes fourteen engineering departments:

1. Computer Engineering
2. Environmental Engineering
3. Electrical and Electronics Engineering
4. Industrial Engineering
5. Physics Engineering
6. Food Engineering
7. Civil Engineering
8. Geophysics Engineering
9. Geology Engineering
10. Chemical Engineering

[9] http://tez2.yok.gov.tr

[10] For example, Sabancı University offers a "Mechatronics Engineering" program which we have classified under the "Mechanical Engineering" field. Similarly, we have treated "Systems Engineering" in Yeditepe University as "Computer Engineering".

11. Mining Engineering
12. Mechanical Engineering
13. Materials Engineering
14. Metallurgy Engineering

At the end, we were able to collect very detailed information on almost 3,500 Ph.D.'s in engineering faculties of Turkish universities.

To our knowledge, the Ph.D. market has not been investigated empirically in Turkey. Thus, we believe that this unique data provide very valuable information about some characteristics of the Turkish universities, such as number of students per faculty member, country and continent of the Ph.D.'s, as well as trends over the course of years. In Section 3, we present our major findings in Turkey's Ph.D. Market in engineering with respect to the academic staff data.

2.2 Publications

The second main part of our dataset includes the academic publications. For a descriptive analysis of academic research performances in sub-fields of engineering in Turkey, as well as for using in regression analyses to observe the relationship between research productivity and its determinants; we need data on publications by the academic scholars in Turkish universities. For this purpose, we collected information regarding the publications in academic journals for all of the engineering departments in Turkey.

Our source for this data was the famous Thomson Reuters web site; Web of Science.[11] This website is the largest source that keeps track of information about academic research around the world. It provides a very rich publication database with extensive information regarding publications and their relative qualities. In addition, it permits to apply numerous search filters on publications to obtain more specific information.

In accordance with our purpose of the analysis of publications in Turkish universities and also to obtain accuracy in collected data, we have applied some of the available filters to our search. First, we used the website's official field categories listed in "Science Index"

[11] http://www.isiknowledge.com

(SSI).[12] We did not use the "Social Science Index" categories since our scope in this study is only the engineering fields and fields listed in the "Social Science Index" are irrelevant.

Second, we applied Ulusal Akademik Ağ ve Bilgi Merkezi (ULAKBİM) search keywords for the university names in our dataset. ULAKBİM, a Turkish research organization working on the academic research activity in Turkey, has very recently completed a thorough work on academic productivity in Turkey regarding publications and citations and presented its findings in the book *Türkiye Bilimsel Yayın ve Atıf Göstergeleri* (2007). Along with their research results, they also published the search keywords for university names that they used in their study. They applied a very large number of search keywords for each Turkish university, taking into account different possible names and mistyping of institutions' names stated in a publication. We used these available keywords to control over several names of institutions, as well as possible errors in them. [13]

Third, we collected publication data only for the year 2008. On a university level, we downloaded all of the publications classified under the "Science Index Categories" in the year 2008.

Because of the scope of the study, we had to restrict this data to a single year. Publication dataset was constructed for each university and then each publication was matched to the academic staff data. To be more precise, with the help of computational instruments and some computer programming, we matched each and every published article to its author(s) in our academic staff data, in a given university. In this sense, we were able to identify all of the publications that a scholar in an engineering faculty published, in the year 2008.

A panel data over time would have allowed us a better control for some of the university fixed effects, which may play an important role in research productivity. Moreover, it may the case that in the year 2008, some extreme circumstances in some of the universities were present. However, although our source for publications potentially allows us to collect publication data for every year, producing a reliable dataset of academic staff over time has several problems due to mobility and retirement issues. Therefore, this forces us to use data for a single year. Yet, we believe that a cross-section analysis including other valuable aspects of our unique dataset still enables us to capture a significant portion of the characteristics of academic research in engineering faculties of Turkey and of its determinants.

[12] Full list of "Science Index" categories can be found at: http://science.thomsonreuters.com/mjl/scope/scope_scie/

[13] Full list of university search keywords that we used can be found at: http://www.ulakbim.gov.tr/cabim/yayin/tbyg_1981-2006/ek3.pdf

One other aspect of research productivity is also worth a mention: quality. Our dataset has also information regarding the quality of publications in Turkey. It includes Journal Impact Factors of the academic journals where articles have been published. Our source for these impact factors was the most-commonly used Journal Citation Reports.[14] This website is updated once a year with measurements of journal qualities in numerous aspects. We used Journal Impact Factors for the year 2008, in correspondence with our publication data. By doing so, we were able to measure also the quality of research produced in Turkey.

At the end, the publication data consisted of some forty-three Turkish universities. Our findings show that there were almost 2,500 publications in engineering faculties of Turkey in 2008. These publications greatly vary among universities, fields, and also on qualities. The next section provides detailed descriptive statistics on this issue.

3 Descriptive Analysis of the Ph.D. Market in Engineering in Turkish Universities

One of the main purposes of this study is to explain the current characteristics of the Ph.D. Market in Engineering in Turkey. As previously discussed, we collected information on educational and employment backgrounds of the Ph.D.'s as of year 2009. This dataset enabled us to observe the current Ph.D. market conditions in Turkish universities.

In total we have 3,417 Ph.D.'s in engineering faculties from a number of forty-eight universities. In the following subsections, we present our findings with respect to different aspects of the current situation in engineering faculties in Turkish academia.

3.1 Academic Staff

3.1.1 Ph.D.'s by Country

The dataset regarding the Turkish scholars in engineering faculties reveals very remarkable points. Most importantly, we observe that the country preferences for pursuing a doctoral degree are fairly limited to only a small number of countries.

[14] http://www.isiknowledge.com

The distribution of Ph.D.'s over countries is shown in Table 1. We see that of the 3,417 Ph.D.'s in Turkey, some 2,315 of them (67.75%) have obtained their highest education in Turkey, to which hereafter we refer as "Domestic Ph.D.'s". Thus, in return, around one in three (32.25%) have obtained their Ph.D. abroad, to which we refer as "Foreign Ph.D." s.

Following Turkey, the second source country for Ph.D.'s is the U.S.A. with almost 20%. This finding coincides with the general consensus in Turkey as well as our prior expectations. U.S. universities indeed constitute the center of the brain drain in graduate education. A more interesting fact we came upon is that U.S. universities grant Ph.D.'s to Turkish students almost three times more than the following country in the list. Table 1 shows that the country following U.S.A. is England, with around 7.5%. These three countries, Turkey, U.S.A and England make up almost 95% of all of the Ph.D.'s in Turkey.

Table 1 Ph.D. distribution in Turkey, by country

Ph.D. Country	Frequency	Percent
Turkey	2,315	67.75
USA	665	19.46
England	252	7.37
Germany	56	1.64
Canada	28	0.82
France	19	0.56
Scotland	16	0.47
Wales	12	0.35
Japan	11	0.32
Switzerland	10	0.29
Austria	6	0.18
Russia	5	0.15
Azerbaijan	4	0.12
Holland	4	0.12
Australia	3	0.09
Belgium	3	0.09
South Africa	2	0.06
Denmark	1	0.03
Finland	1	0.03
Hong Kong	1	0.03
Ireland	1	0.03
Sweden	1	0.03
Ukraine	1	0.03
Total	3,417	100

As we restrict our focus only to the foreign Ph.D.'s and their distribution over countries, we observe that U.S.A. is by far the top choice of Turkish students to receive higher education. As shown in Table 2, of 1,102 foreign Ph.D.'s in engineering faculties of Turkey, some 665 students (around 60%) have obtained their doctoral degree in the U.S.A. This fact, again, may be interpreted as a further approval of quality and popularity of American universities in higher education. England follows U.S.A. with almost 23% percent in Ph.D. preferences, whereas Germany and Canada are third and fourth with around 5% and 2.5%, respectively. Within the Foreign Ph.D.'s only, we observe that U.S.A. and England are the leading countries to grant doctoral degrees to Turkish students with almost three out of four students (73%) having received their degrees in one of these two countries.

Table 2 Foreign Ph.D.'s in Turkey, by source country

Ph.D. Country	Frequency	Percent
USA	665	60.34
England	252	22.87
Germany	56	5.08
Canada	28	2.54
France	19	1.72
Scotland	16	1.45
Wales	12	1.09
Japan	11	1.00
Switzerland	10	0.91
Austria	6	0.54
Russia	5	0.45
Azerbaijan	4	0.36
Holland	4	0.36
Australia	3	0.27
Belgium	3	0.27
South Africa	2	0.18
Denmark	1	0.09
Finland	1	0.09
Hong Kong	1	0.09
Ireland	1	0.09
Sweden	1	0.09
Ukraine	1	0.09
Total	1,102	100

3.1.2 Foreign Ph.D.'s over Time

Our dataset also allowed us to identify time–specific characteristics of the Ph.D. market in engineering faculties in Turkey. We were able to observe the year of the received degree, as of year 2009. The following Figure 1 shows the kernel density frequency estimations of Foreign Ph.D.'s over time from our dataset.

At this point, let us make an important remark before interpreting Figure 1. As mentioned in the previous section, our dataset consists of all the Ph.D.'s in Turkish universities as of the academic year 2009 – 2010. We gathered information about the *currently* employed staff in universities. In contrast, a large number of people with Ph.D.'s before a certain date do not appear in our dataset since these people have most probably retired before 2009 and consequently they were not listed under universities' current academic staff. So, this frequency estimation graph is only representative of the academic year 2009 – 2010.

Figure 1 Kernel estimation of year of received Foreign Ph.D.'s in Turkey, over time

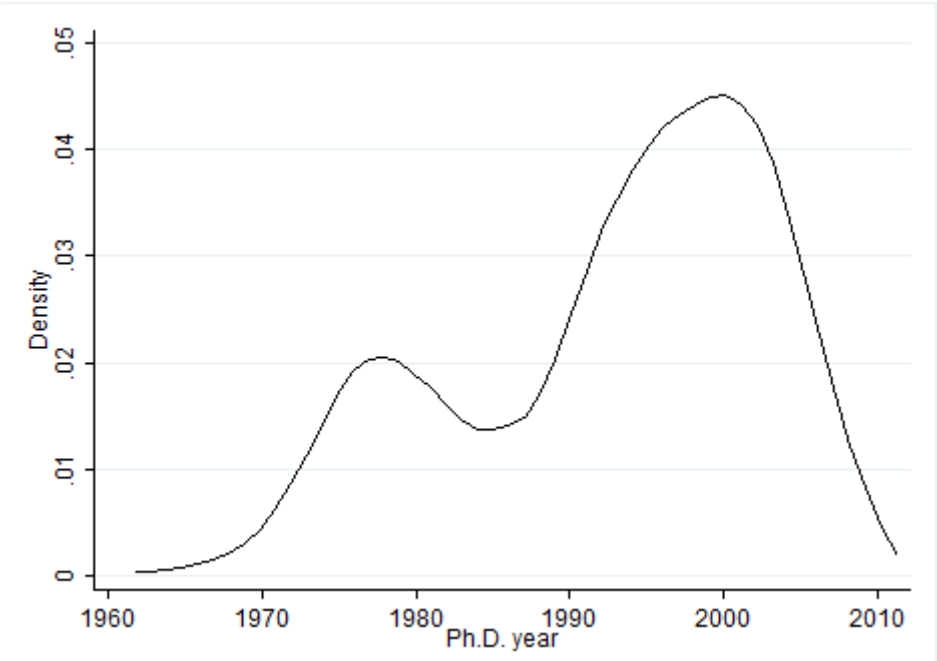


Figure 1 shows some important time trends in foreign Ph.D.'s as of 2009. We observe a boost in obtained degrees starting from the end of 1980s, followed by a steady rise for almost a decade until reaching a peak around 2000. We infer this as the most likely year the Ph.D.'s working in Turkey as of 2009 have obtained their degrees. After 2000, we observe a decrease which trivially makes sense given the characteristics of our dataset. People who have obtained

a Ph.D. recently, say in the last three years prior to 2009, may still be following a post-doctorate program in their Ph.D. university or did not prefer to return to Turkey yet for other individual reasons.

Figure 1 also allows us to examine another important feature of the Ph.D. market in Turkey. The number of obtained Ph.D.'s from abroad has increased almost threefold between 1990 and 2000. Moreover, there appears to be a hump-shaped trend in Foreign Ph.D. observation counts in 1980s. The decline in the number of Foreign Ph.D.'s may be due to the political history and extreme circumstances in Turkey around 1980.

Ph.D. Market Characteristics at University Level

Throughout the process of collecting academic staff data, we used Turkish universities and their engineering faculties as our starting point. Thus, our dataset involves a specification for universities as well as engineering faculties. In this subsection, we present characteristics of the Ph.D. Market in Turkey on these levels.

3.1.3 Foreign Ph.D. Shares in Universities

Our prior expectations about the Foreign Ph.D. shares in academic staff in Turkish universities were that they would possess a very large variation resulting from several reasons. First, there exists a conventional wisdom about the quality of Turkish universities for a very long period of time that associates higher Foreign/Domestic Ph.D. ratios in universities to higher academic standards. Second, the distinction between public and private universities is of great importance in Turkish educational system. Private universities are presumed to offer better facilities and rewards so that we would expect them to appeal Ph.D.'s from abroad more. In addition, it can be assumed that private universities would prefer to have more Foreign Ph.D.'s relative to public universities in order to attract more and capable students by recruiting "well qualified" instructors and researchers to their staff.

Our findings with this respect are in accordance with prior expectations. Table 3 shows the Foreign Ph.D. shares in engineering faculties in Turkish universities. At the top of the list we see, as expected, three private universities: Bilkent University, Sabanci University and Koc University. Their academic staff consists of Foreign Ph.D.'s around 85%. In other words,

for every hundred Ph.D.'s in engineering faculties of these universities, on average only fifteen of them have obtained their degree from a Turkish Ph.D. granting institution.

Following the top three universities, we spot Bogazici University in the 4th place, followed by Izmir Institute of Technology and Yeditepe University all above the 70% level. Strikingly, we witness a large variation in Foreign Ph.D. shares in Turkish universities in a general perspective. While the top-rank universities have more than 80% Foreign Ph.D.'s in their academic staff, at the other extreme we observe a large number of universities with no more than 15%. We also observe that all of the private universities are placed in the first half of the Foreign Ph.D. share ranking. In the light of our research purpose of uncovering the determinants of academic research productivity in Turkey, this variation, we believe, plays a very significant role.

Table 3 Foreign Ph.D. shares in engineering faculties of Turkish universities

University	Foreign Ph.D. Share
Bilkent University	0.877
Sabancı University	0.843
Koç University	0.842
Boğaziçi University	0.717
Izmir Institute of Technology	0.710
Yeditepe University	0.704
Middle East Technical University	0.654
Gebze Institute of Technology	0.574
Kadir Has University	0.563
Işık University	0.526
Çukurova University	0.418
Marmara University	0.410
Kırıkkale University	0.407
Hacettepe University	0.360
Galatasaray University	0.353
Gaziantep University	0.353
Istanbul Kültür University	0.346
Çanakkale University	0.333
Dumlupınar University	0.324
Çankaya University	0.300
Karadeniz Technical University	0.276
Mersin University	0.261
Ankara University	0.255
Gazi University	0.243
Anadolu University	0.241
Dokuz Eylül University	0.238
Pamukkale University	0.226
Uludağ University	0.219
Niğde University	0.200

Table 3 *(cont.)*

University	Foreign Ph.D. Share
Zonguldak University	0.196
Ege University	0.191
Istanbul Technical University	0.188
İnönü University	0.179
Ondokuz Mayıs University	0.172
Akdeniz University	0.171
Sakarya University	0.159
Kocaeli University	0.135
Dicle University	0.132
Cumhuriyet University	0.130
Yıldız Technical University	0.128
Selçuk University	0.114
Istanbul University	0.094
Erciyes University	0.093
Average	0.345

Our data also reveals another striking characteristic of Ph.D. preferences in terms of university types. To be precise, the distinction between public and private universities appears to be very deep. In the academic staff of all *public* universities in our sample, 71% of scholars have obtained their doctoral degree in Turkey. In a remarkable contrast, this figure for *private* universities is only 35%. This finding, again, confirms the conventional wisdom in Turkey which states that private universities succeed in attracting foreign Ph.D.'s more.

3.1.4 Domestic Ph.D. Distribution

In this subsection, we present our results regarding the Domestic Ph.D. market in Turkey. Table 4 shows the distribution of Turkish universities which have granted doctoral degrees to the scholars in our dataset. In total, some 2,315 Ph.D.'s have received their degrees from Turkish institutions.

Table 4 Domestic Ph.D. distribution

Ph.D. University	Frequency	Percent
Istanbul Technical University	369	15.94
Yıldız Technical University	214	9.24
Middle East Technical University	198	8.55
Dokuz Eylül University	150	6.48
Istanbul University	140	6.05
Ankara University	113	4.88
Ege University	104	4.49

Table 4 *(cont.)*

Ph.D. University	Frequency	Percent
Hacettepe University	103	4.45
Karadeniz Technical University	92	3.97
Boğaziçi University	86	3.71
Selçuk University	85	3.67
Gazi University	80	3.46
Çukurova University	77	3.33
Anadolu University	61	2.63
Gaziantep University	47	2.03
Sakarya University	43	1.86
Cumhuriyet University	38	1.64
Uludağ University	37	1.60
Erciyes University	34	1.47
Kocaeli University	32	1.38
Eskişehir Osmangazi University	30	1.30
Fırat University	29	1.25
Bilkent University	25	1.08
Ondokuz Mayıs University	21	0.91
Pamukkale University	14	0.60
Marmara University	13	0.56
Atatürk University	12	0.52
Gebze Institute of Technology	11	0.48
Zonguldak Karaelmas University	8	0.35
Trakya University	7	0.30
Süleyman Demirel University	6	0.26
IDMMA	5	0.22
Akdeniz University	4	0.17
Celal Bayar University	4	0.17
Inönü University	4	0.17
Kırıkkale University	4	0.17
Dicle University	3	0.13
Mersin University	3	0.13
Işık University	2	0.09
Izmır Institute of Technology	2	0.09
Başkent University	1	0.04
Dumlupınar University	1	0.04
Harran University	1	0.04
Koc University	1	0.04
Yuzuncu Yil University	1	0.04
Total	2,315	100.00

With regard to our data specification of scholars in *engineering* faculties, long-established technical universities come in first places in granting Ph.D. to Turkish students, as one would expect. Istanbul Technical University, Yıldız Technical University and Middle

East Technical University together make up for one-third of the domestic Ph.D.'s received in Turkey. Following these three institutions come Dokuz Eylül University, Istanbul University and Ankara University in respective spots, which in total, together with the technical universities mentioned, count for more than half of the domestic Ph.D.'s in Engineering faculties.

To conclude, we believe that above analysis provides a general overview about the domestic Ph.D. market in and features of both higher educational system and academia in Turkey.

3.2 Publications

Second part of our descriptive analysis covers the academic publications for the year 2008 from the engineering faculties in Turkish universities, using data that matches academic publications to its authors in a given university.

In 2008, there were a total of 2,423 articles published in academic journals listed under Science Index Category in Thompson's website Web of Science, from the 43 universities in our sample. Since our dataset includes information on academic research both at university and departmental levels, we present our findings for both levels in a respective manner in the following subsections. We also make distinctions regarding the two aspects of research productivity; namely quantity and quality.

3.2.1 Publications by Universities

Quantity

At a university level, the amount of academic research productivity in Turkish universities appears to contain very large differences. In the year 2008, Middle East Technical University is the most productive institution with almost 200 academic publications, followed by Dokuz Eylül University and Istanbul Technical University with around 150. However, the total number of publications in a given university could be misleading since some universities are larger than others and have a higher number of scholars in their academic staff. Since, larger universities are expected to produce more research; the total amount is not necessarily related to overall productivity.

To overcome this issue, we divided the total number of publications to the total number of Ph.D.'s, to obtain an average publication count. This figure represents the average number of publications *per one scholar* in a given university. By doing so, we controlled for the mentioned size effect and were able to order universities' research production on a comparable basis.

Table 5 depicts the average publications in the year 2008. As in the case of foreign Ph.D. shares, we witness a large variation in average publications among universities. Koç University comes in first in the ranking with 1.76 publications per scholar, while two public institutions Ondokuz Mayis University and Izmir Institute of Technology come in second and third with 1.56 and 1.45 publications, respectively. Gebze Institute of Technology, which differs from a typical Turkish university in some aspects, is at the 5th place. Surprisingly, Middle Eastern Technical University, which is the most productive institution in nominal terms, falls to the 14th position out of 43, whereas Yıldız Technical University (fourth in nominal terms) is to be found only in the last ten.

Table 5 Average publications, by university

University	Avg. Publication per Scholar	University *(cont.)*	Avg. Publication per Scholar
Koç University	1.763	Ege University	0.673
Ondokuz Mayıs University	1.569	Istanbul University	0.664
Izmir Institute of Techn.	1.452	Akdeniz University	0.659
Çankaya University	1.450	Niğde University	0.644
Gebze Institute of Techn.	1.185	Inönü University	0.643
Bilkent University	1.169	Dicle University	0.632
Galatasaray University	1.000	Karadeniz University	0.621
Boğaziçi University	0.991	Mersin University	0.587
Çanakkale University	0.967	Cumhuriyet University	0.580
Erciyes University	0.907	Marmara University	0.557
Hacettepe University	0.892	Uludağ University	0.547
Ankara University	0.882	Yıldız Technical University	0.500
Pamukkale University	0.845	Sakarya University	0.444
Middle East Technical Univ.	0.821	Yeditepe University	0.407
Sabancı University	0.804	Dumlupınar University	0.353
Dokuz Eylul University	0.790	Işık University	0.316
Selçuk University	0.772	Gaziantep University	0.294
Çukurova University	0.759	Kocaeli University	0.270
Anadolu University	0.759	Zonguldak University	0.239
Kadir Has University	0.688	Kırıkkale University	0.222
Gazi University	0.687	Istanbul Kültür University	0.192
Istanbul Technical University	0.673	Average	0.741

Quality

In addition to the quantity measurements, research productivity has another dimension which should be taken into account: quality. While analyzing how much work has been made is very important, the question of quality conditional on published articles is also crucial. In this sense, we included a quality dimension to our dataset regarding the publications of the engineering faculties in Turkey.

Let us recall that our measurement of quality in academic research relies on the journal impact factors. We collected 1-year impact factors of the year 2008 for all of the academic journals that the articles in our dataset were published in. On a university level, we have calculated the *average* of the journal impact factors which provided us an understanding of the quality aspect in research and an opportunity to compare Turkish universities with this regard.

Table 6 Average Impact Factors, by university

University	Average Impact Factor	University (*cont.*)	Average Impact Factor
Gaziantep University	2.815	Ege University	1.437
Koç University	2.707	Dokuz Eylul University	1.418
Boğaziçi University	2.182	Inönü University	1.411
Gebze Institute of Techn.	2.070	Selçuk University	1.385
Işık University	1.956	Uludağ University	1.379
Marmara University	1.876	Çanakkale University	1.375
Çankaya University	1.737	Zonguldak University	1.372
Istanbul University	1.729	Cumhuriyet University	1.359
Mersin University	1.671	Hacettepe University	1.347
Anadolu University	1.655	Istanbul Technical University	1.322
Dumlupınar University	1.654	Niğde University	1.252
Bilkent University	1.648	Akdeniz University	1.252
Sabancı University	1.627	Dicle University	1.244
Izmir Institute of Techn.	1.592	Pamukkale University	1.193
Kocaeli University	1.587	Karadeniz University	1.150
Yeditepe University	1.577	Kadir Has University	1.032
Middle East Technical Univ.	1.553	Erciyes University	1.016
Ankara University	1.505	Kırıkkale University	0.933
Yıldız Technical University	1.476	Galatasaray University	0.882
Sakarya University	1.445	Çukurova University	0.876
Istanbul Kültür University	1.439	Ondokuz Mayıs University	0.779
Gazi University	1.438	Average	1.496

Table 6 above demonstrates the average impact factors of the journals that publications took place for each university. These values reveal several interesting facts about the distinction between two aspects of productivity. At the top of the list, we see Gaziantep University which is among the last five on average paper quantity. Second, two of the three private universities with the highest Foreign Ph.D. share – Bilkent and Sabanci University - are only on 12th and 13th places, respectively. Third, Ondokuz Mayıs University scholars appear to produce the lowest quality articles although on average paper per scholar, their university is the second most productive one.

This cross-sectional publication data for the single year of 2008 may be missing some unobserved year-specific factors. A given university, for example, might have been exposed to some unexpected circumstances resulting in a different publication outcome than its regularity. Nevertheless, we believe that these findings themselves offer a quite valuable insight regarding university performances on academic research in Turkey.

3.2.2 Publications at Department Level

Since the characteristics of our dataset allowed us to do so, we could also make distinctions regarding the different sub-fields in engineering. In total, our dataset is divided into 14 different departments in engineering Faculties of turkish universities. The list of the departments can be found at section 2. Similar to the discussion at university level, we now introduce quantity and quality aspects of research productivity at department levels in following subsections.

Quantity

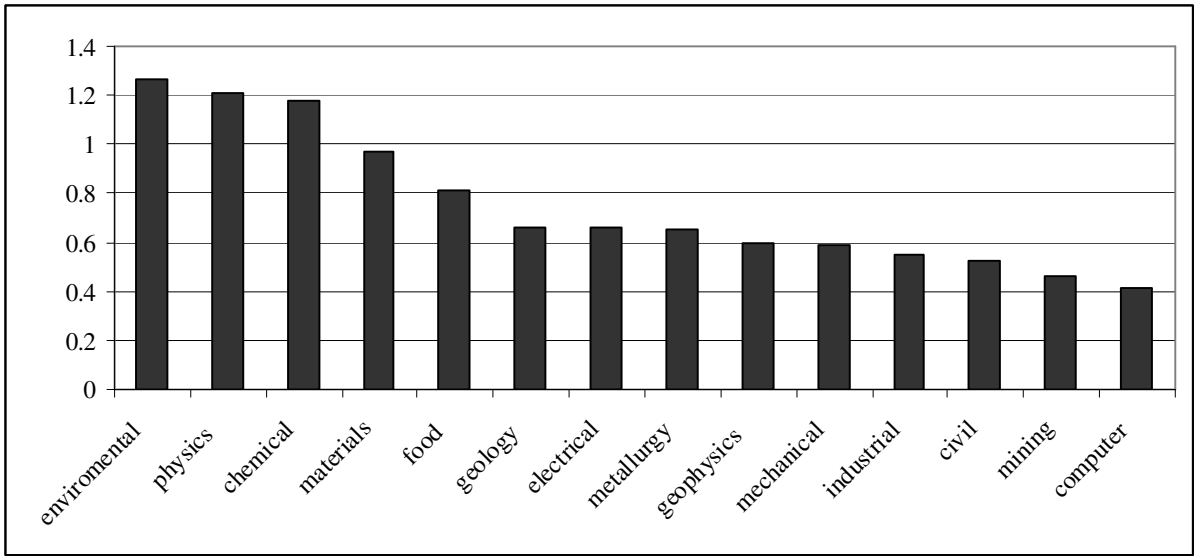
Our data on academic research productivity also reveals quite large differences among sub-fields of engineering. On nominal terms, electrical engineering faculties are the most productive field in Turkish universities with almost 400 publications out of a total of 2,423 articles published in the year 2008. Following electrical engineering, we see environmental and chemical engineering faculties in second and third places with almost 350 publications each. At the lower end, we observe geophysics, materials engineering departments in terms of academic productivity.

However, without controlling for the scale differences, one can again make misleading interpretations. Departments with a greater number of scholars are expected to produce more.

Hence, as in the case of university levels, we have calculated an average publication figure at department levels. This value represents the average publication *per scholar* in a given department.

As depicted In Figure 2, environmental engineering faculties are the most productive sub-field in 2008: a Ph.D. in environmental engineering has produced over 1.20 articles. Second is physics engineering while chemical engineering field comes third which also had the third place in ranking in nominal terms. The leading faculty in nominal terms, electrical engineering is spotted at the middle on 7th spot among 14 sub-fields with around 0.60 average publications per scholar.

Figure 2 Average publications, by department



Lastly, computer engineering appears to be the least productive faculty with around 0.40 publications per scholar, which will be of some implication when we return to the quality aspect of research productivity at department level.

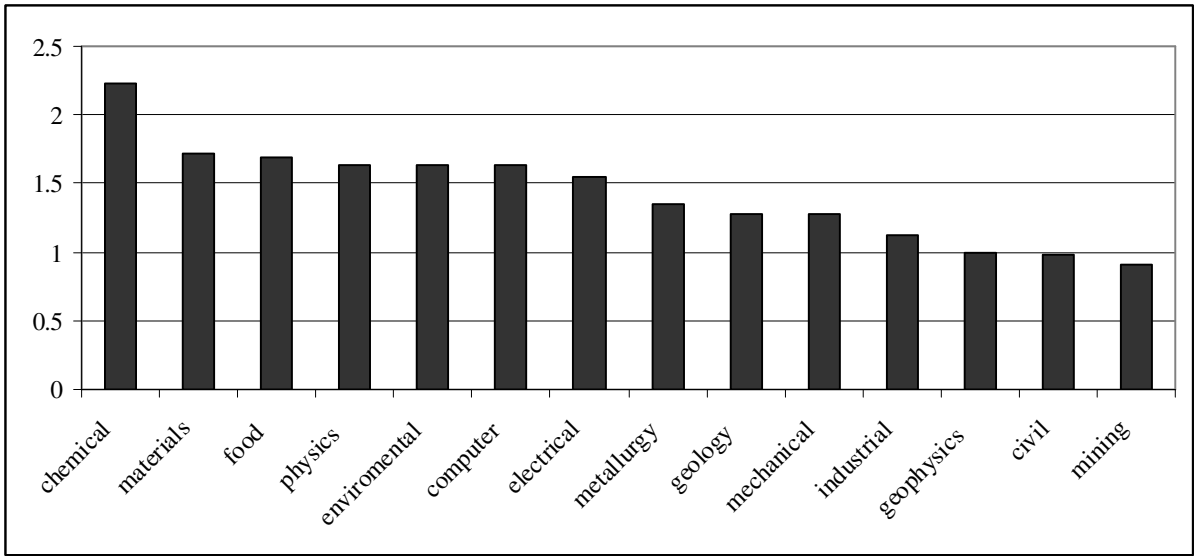
In sum, we observe that average academic research with respect to sub-fields of engineering involves large differences in Turkish universities. The gap between the first and the last field is almost threefold.

Quality

On the quality aspect of research productivity among engineering fields, we see a quite different ranking than the amount of work. As before, we apply average impact factors of academic journals that the articles were published in as our measurement of research quality.

Figure 3 below depicts our findings with respect to the quality of publications on department level. Chemical Engineering faculties produce by far the highest quality research with average impact factor well above 2.00 and almost 30% higher than the subsequent field of materials engineering. Interestingly, environmental engineering faculties, which are the most productive in terms of quantity, are at 5th place. Moreover, our results reveal that computer engineering faculties' publications found places in relatively higher ranked journals, even though the average amount of computer engineering related publications was the lowest among all disciplines. In contrast, civil and mining engineering faculties seem to generate the lowest quality work just as they were found to be at the bottom level in terms of quantity.[15]

Figure 3 Average Impact Factors, by department



3.2.3 Publications over Career

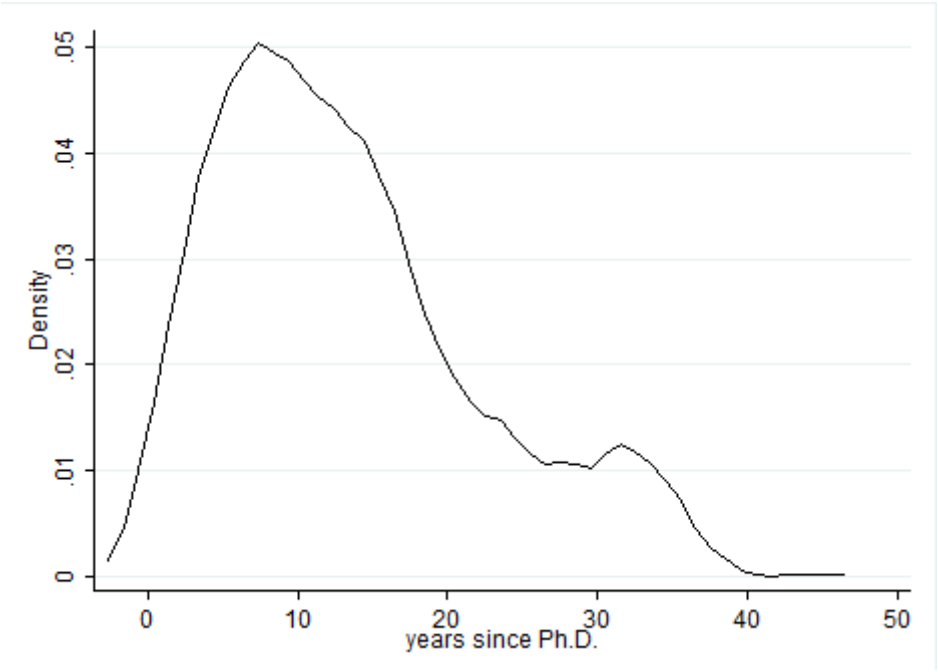
Last but not the least; we finish this section with some statistics related to the productivity of scholars over their careers in Turkish universities. As discussed earlier, literature on academic research productivity points that age plays a central role in determining productivity. Studies conducted in different countries indicate big resemblances in patterns of academic research. To be precise, there are a large number of studies cited in the introduction which show that academic research increases by the start of the career after receiving a Ph.D. degree for almost a decade, followed by a steady decrease afterwards until the end of one's career.

[15] It is important to note that using average impact factors for comparing different sub-fields of engineering may have an issue in itself. It may be the case that there are some field-specific factors which affect impact factors of journals. For instance, in a particular field, scholars may be citing other articles too often which would increase the impact factors significantly.

Underlying factors that explain this life-cycle pattern in academia could be several. First, scientists may be losing their motivations for working more efficiently as they age and thus fail to produce as they once did in the starting period of their careers. Second, scholars may tend to engage in non-research activities over the course of years which leads to a decline in publication counts. Devoting their larger share of time to consultancy to the professional world in their areas of specialization or to other administrative duties within their university can interrupt the scholars' academic research activity. Also, the lack of ability to keep up with the newest developments and improving technology in their fields may be a possible explanation of the decline in publications

Graph below clearly illustrates some similarities in publication patterns over time between Turkish Ph.D.'s and their colleagues in other countries showing that academic publications are produced mainly in primary years following the Ph.D. In Turkey, highest number of publications was produced by scholars with tenure of six to twelve years in engineering faculties in year 2008, which together make up for almost a quarter of the entire sample.

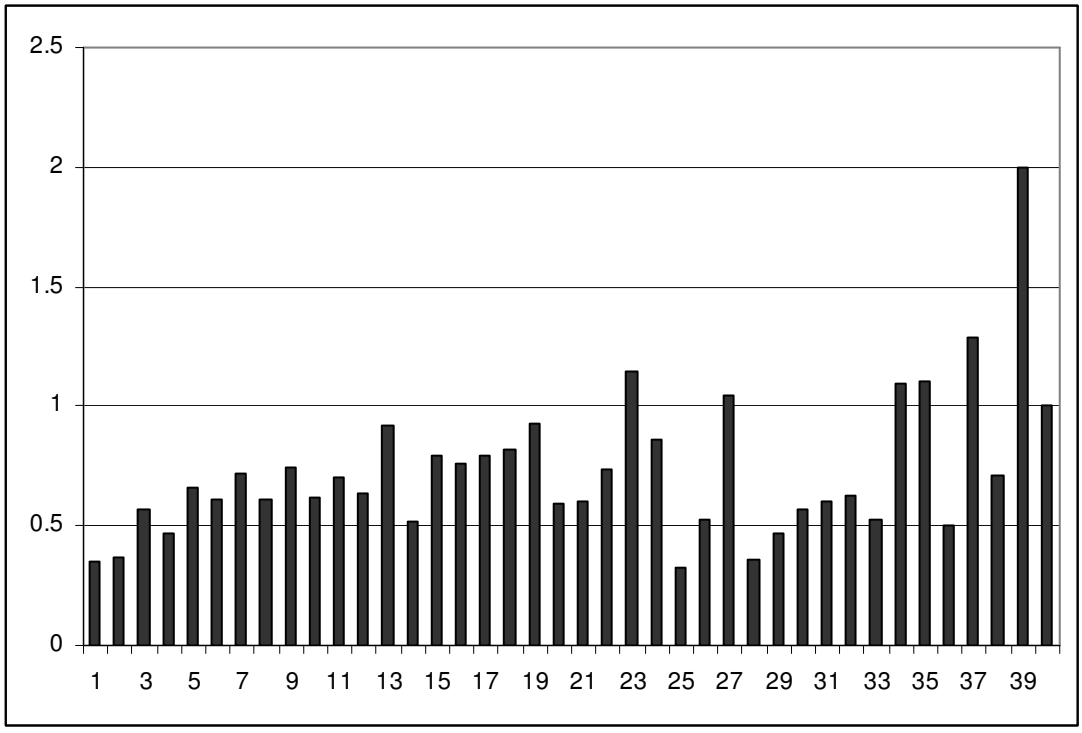
Figure 4 Kernel density estimation of the publications over career.



However, without controlling for the scale differences in terms of years since Ph.D. in our dataset, interpreting the existence of life-cycle effects for Turkish scholars may be

misleading. The number of scholars in our dataset with around 10 years of experience is almost three times larger than the number of scholars with, say, 20 years. So, the difference between the occurrences of age groups should be taken into account. Thus, we have calculated *publications per age group* figures for this purpose and Figure 5 below demonstrates our findings in this regard.

Figure 5 Average Publications, by years since Ph.D.



As can be seen in Figure 5, average publication counts for each age group in our dataset cease to show evidence for life-cycle effects in Turkish academia. Contrary to the findings in the related literature, our results show that Turkish scholars do not follow a declining pattern in academic performance after the primary years of their careers. Except the two scholars with 38 years of experience in our dataset, publication amounts follow more or less a steady fashion with a mean around 0.75 paper in each age group.

On a descriptive nature, we consider these results as an overview of the academia in Turkey and believe that it provides a primary insight on productivity over the course of years. Moreover, the relevant data on career ages of scholars, along with several others including the distinction between foreign and domestic Ph.D.'s, plays an important role as explanatory variables in our regression analysis to investigate the determinants of research productivity in Turkish universities, to which we now turn in the next section.

4 Regression Analysis

Research productivity and its determinants has long been a striking subject among economists. Numerous empirical studies have studied possible determinants of academic performance. In this section, we focus on the determinants of research productivity on empirical grounds adopting similar specifications to existing literature.

As explained in detail in previous sections, our dataset consists of information on academic staff and publications in Turkish universities. We use this dataset to investigate mainly the relation between foreign Ph.D. and academic performance in Turkish universities. That is to say, we do all of our estimations at *university level*: we calculate average values for a given university and treat each university as one observation in our regression analysis. Thus, in total we have 43 observations that possess information about the universities and their characteristics.

Main aim of the regression analyses is to investigate whether source of the doctoral degree of scholars affects academic research activity. Our prior expectations were that foreign Ph.D.'s would have a positive impact on academic productivity in Turkey measured by publications. Hence, our key independent variable in our regression analysis is the foreign Ph.D. shares in engineering faculties of Turkish universities. We also differentiate the ranking of Ph.D. granting institutions, as a measure of quality, which we will explain in the later parts of this section.

Additional to the Foreign Ph.D. shares in universities, we have added several control variables which are central to our research purpose of analyzing research productivity. Our dataset enabled us to control for age effects for scholars, teaching load (both at undergraduate and graduate levels), university age, university type (public or private) and compositional differences among sub-fields of engineering.

Age effects were measured by the average number of years passed since a scholar has obtained her Ph.D., at university level. Teaching load was incorporated as an independent variable into our model with the average number of students *per scholar*, again, at university level. We have used ÖSYM and MEB websites to collect total number of students in engineering faculties.[16] However, our prior expectations on number of students' effect on

[16] Unfortunately, the website of ÖSYM which provides the information on number of newly enrolled students to Turkish universities for the year 2008 was not working properly. So, we used the latest available data for 2007 and multiplied the number of students by four for each university. We did so in order to achieve a reasonable figure for the total number of students in an engineering faculty, since a typical engineering degree requires four years to complete. We also assumed that the number of students who had failed to pass some courses and are

research productivity, on undergraduate and graduate levels separately, were somehow unclear.

Specifically, while the effect of undergraduate student size is expected to be negative since more students in a course call for less time to spend on academic research, direction of the effect of graduate student size was, to our understanding, difficult to assess. It is obvious that teaching a graduate course requires quite a large amount of time and effort (maybe even more than an undergraduate course) which would reduce academic activity. Yet, presence of graduate students could also be interpreted as a positive factor in terms of research. Graduate students are quite frequently appointed as research assistants in university faculties, which could turn out to be very helpful for a scholar in academic productivity. Additionally, some of the graduate programs in Turkish universities require their participants to complete an enhanced academic research in order to be entitled to graduate.

Finally, other related information such as university ages, their institutional structure (public or private) or departmental size effects were also used in our estimations as control variables.

For the dependent variables in our estimations, we have divided our focus into two main aspects of research productivity as discussed throughout this paper - quantity and quality. We used *average publication per scholar* and *average impact factor* as our dependent variables in two separate regressions. We refer to the amount of research and its determinants with the "average publication" values whereas "average impact factor" captures the quality aspect, given that a paper is published.

Moreover, we conducted two additional regressions to investigate the so-called *spillover effect* on Domestic Ph.D.'s. We used - as dependent variables - *average publication per scholar* for Ph.D.'s with a degree received domestically and *average impact factor* likewise regarding the scholars with a degree from Turkey. By doing so, we aim to capture whether the presence of foreign Ph.D.'s (along with other factors) had an indirect effect on those who did not receive their degree abroad.

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repeating a year, and the number of students who had quit the school to be equal so that these two figures cancel each other out in terms of teaching load for a scholar. We believe that this assumption is quite reasonable for our purposes and thus multiplying the number of students in a given year by four gives a fair estimate of the total number of students in the whole faculty.

4.1 Regression Results

4.1.1 Foreign Ph.D. Share

Table 7 shows our first estimations on determinants of research productivity. Two columns represent results of separate regressions with "average publication per scholar" and "average impact factor" at university levels as our dependent variables. Accordingly, first column depicts the determinants of research on quantity, whereas the latter corresponds to quality.

Table 7 Regression results with Foreign Ph.D. share

	Avg. Publication per Scholar	Avg. Impact Factor
Foreign Ph.D. Share	**0.576***	**0.695***
	(2.072)	(2.052)
Avg. Student	**-0.010****	-0.000
	(-2.769)	(-0.096)
Avg. Grad Student	0.013	-0.016
	(0.502)	(-0.515)
Avg. Career Age	0.132	**0.288***
	(1.154)	(2.061)
Avg. Career Age. Sq.	-0.006	-0.011
	(-1.357)	(-1.876)
University Age	0.003	-0.002
	(0.736)	(-0.485)
Constant	0.091	-0.357
	(0.135)	(-0.435)
R-squared	0.360	0.286

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. t-statistics in parentheses.
Statistically significant coefficients are marked **bold.**

First column in Table 7 shows, first and foremost, that our prior expectations and the main purpose of this study in general appear to have been verified. Ph.D.'s received from abroad have indeed a positive and significant effect on academic research in Turkey.

As the first row in the table shows, a one percentage point increase in the Foreign Ph.D. share in a given university increases the average number of papers per scholar by 0,56 in a year. That is, a scholar produces 0,56 papers more whenever the organization she belongs to increases its percentage of Foreign Ph.D.'s on academic staff by one point. For a clearer interpretation, related calculations reveal that a one standard deviation increase in foreign Ph.D. share leads to a 17% increase in average paper. Also, with a t-value of 2.072, our estimations show that this positive effect of Foreign Ph.D. Share's is significant at 5%. This

result itself, without subject to any further specifications which will be introduced in the following section, possesses very important interpretations.

Increasing the Foreign / Domestic Ph.D. ratio in a given university significantly raises its academic activity in publication terms. The university produces more academic research with the presence of its staff that have obtained a degree from abroad. Underlying factors that cause this phenomenon could be several. One possible explanation is that the quality of graduate education in foreign universities is higher relative to the ones in Turkey. Latest available technology, excellence in academic staff, inspiring environment for research, better career opportunities after receiving the degree and alike may make those universities preferable. After all, that is perhaps the most obvious reason of the brain drain in graduate education context. Students decide to leave their countries and prefer to continue studying abroad because they believe that the education they will receive and skills they will obtain upon completion will be superior in such a case. Consequently, they will be more equipped for research as a member of an academic organization, whether they return to their country of origin or stay elsewhere.

The results of this regression presented above are in line with these expectations. Among Turkish universities, a higher degree obtained from abroad helps increasing one's academic work performance. It is obvious that not all Ph.D.'s follow an academic path in their career – some prefer to work in the professional world. Nevertheless, for the ones that decide to stay in academia, having received their degree from a foreign country affects their research activity in a positive way. Likewise, on the university level our interpretations are quite similar: having a larger share of Foreign Ph.D.'s in its academic staff significantly increases the amount of its academic research.

Regarding the other determinants of academic research in Turkey, our estimation again demonstrates some important results. First, teaching load is negatively correlated with academic research and the effect is largely significant with a t-value of 2.769. As the average of undergrad students per scholar increases by one, average number of papers decrease by 0.01. This is quite logical since an increase in number of students would trivially lead to less available amount of time devoted to academic research. On the other hand, the effect of teaching load on graduate level, in accordance with our expectations, appears to be insignificant. This may be due to the cancelling-out effect of graduate students as discussed.

Second, the results show that the respective signs of the coefficients *Avg. Career Age* and *Avg. Career Age Squared*, while not statistically significant, are as expected: the sign of the former is positive whereas the latter is negative. Thus, it can be interpreted that academic

research increases with age, yet only in a diminishing manner. This result totally agrees with the empirical results of similar studies conducted in this area. In general, Life-cycle hypothesis states that research productivity declines with age.

On the other hand, insignificance of the coefficients in our study contrasts with the existing literature which may be due to our particular specifications. In previous studies, academic research is measured on a cumulative basis over years. In contrast, in our analysis we were restricted to use a cross-sectional data of the year 2008 for reasons that have been explained, and were not able to perform a panel-data analysis over a multiyear time span. With this regard, we have used an average of years passed since Ph.D. at university level. An observation in our sample corresponds to the average number of years of all scholars' careers, in a given university. Therefore, our use of career years of this sort may have caused the difference in our results with the existing literature. Yet, we carefully avoid making any clear-cut conclusions in this regard.

For the other aspect of research productivity, we again find that Foreign Ph.D.'s play an important role on the *quality* of academic research. As depicted in the second column of Table 7, foreign Ph.D. share in a university has a positive (and statistically significant) coefficient. Average of the impact factors of journals increases 0.695 with a one percentage point rise in foreign Ph.D. share. Following calculations also show that a one standard deviation increase in foreign Ph.D. share results in a 10% rise in average impact factors. The underlying factor which may have caused this phenomenon is again very straightforward: a degree obtained abroad yields better education, skills and alike. This results in better quality publications in higher ranking journals. Since our estimations are executed on a university level, we conclude that a larger increase in Foreign Ph.D.'s relative to Domestic Ph.D.'s in academic staff leads to higher quality publications from Turkish academic institutions.

Interestingly, our results do not show any correlation between quality of research and teaching duties. Even though both signs of the coefficients of average undergraduate and graduate student numbers per scholar are negative, they cease to show any significance. We interpret this finding as follows. The average of impact factors are by definition measured only for published papers. Thus, *given that* a scholar publishes a paper, an increase in her teaching load does not cause a decline in her publication's quality.

This result is quite noteworthy and explains a key aspect of academic research. With regard to our previous descriptive results that show great variance among quantity and quality aspects of research in Turkish universities, this insignificance of teaching load on quality

deserves attention. To be sure, further analyses and considerations are to be made in order to get a better insight on the issue.

For the third variable, we observe that the age (and consequently the experience) does play an important role in research quality. With a negative sign on the second-degree, the coefficient of years passed since Ph.D. is positive and significant at 5% level. Quality of research increases in career, but on a diminishing rate: the more years passed since the Ph.D., the higher the impact factor of journals that publications were published in. Moreover, this increase follows a declining fashion as observed by the negative sign in the second-degree variable, *Avg. Career Age Squared.*

Our specification on this control variable, in return, allows us to make the following explanation: If we were to compare two engineering faculties of Turkish universities in their research quality, the one with a higher average career years of its scholars would produce higher quality publications. But, the difference between qualities would get smaller as average of career years among scholars was to increase in both universities.

Together with the findings on quantity, we believe that these age-based effects on academic research in Turkey have extreme importance. We find that more time and experience in academia does not lead to higher publication amounts - contrary to the reasoning of accumulation of human capital - while it does positively affect the quality of publications. Yet, because of certain specifications in our dataset mentioned above, we avoid stating any strong causality and only refer to them as preliminary conclusions.

Finally, as our last control variable, we do not find any significant effect of university age on academic research productivity. Both on quantity and quality levels, how many years that the organization exists is not correlated to academic research.

In a wide subject such as academic research, there are clearly numerous factors that may affect productivity of scholars. In this sense, it is possible that our analysis has some omitted factors that we have not taken into account in our primary analysis. Therefore, instead of stating causality, we consider that there exists a strong *correlation* between, among others, foreign Ph.D. shares and academic research conducted in Turkish universities.

Still, we applied some further specifications in our analyses in order to capture some of the possible omitted factors, which we present in the following subsections.

4.1.2 Specification of Foreign Ph.D. Quality

Our primary specification discussed above, though providing some insight, treats all foreign Ph.D. degrees as equivalent. That is, in our previous specification, location of the university was the only factor we took into account – either abroad or domestic, and we have used Foreign Ph.D. shares of universities as our key independent variable.

Yet, this assumption of treating each foreign university as equals overlooks an important fact. There are large variations in qualities among foreign-based universities (as well as domestic ones). So, a degree obtained from a, say, university X may be far more valuable than, say, a university Y. In this regard, graduates from a certain university may be more equipped for academic research for many obvious reasons. To control for these differences within foreign universities themselves, we consider some further specifications that takes into account such differences.

We used the commonly used global rankings of universities in engineering field presented by Shanghai Jiao Tong University for the year 2009.[17] This list consists of a ranking of the first 100 universities in the world. We matched this ranking of universities to the information on the origin of the doctoral degrees in our dataset. We divided school quality into three sub-groups: schools in the first 20, between 20th and 50th and between 50th and 100th spot in the rankings. At last, instead of a single "Foreign Ph.D." share as in our previous regression, we defined three new independent variables: "Top 20", "Top 20-50" and "Top 50-100" shares for each university.

Such further specification allows us to make a more in-depth analysis. Keeping other control variables same as before, we were able to pinpoint the effects of each school group and whether one is linked to academic research more than the other. Table 8 below illustrates the results from this regression.

The results of the second regression provide further insights about the effects of the brain drain for graduate education in Turkish context. As can be seen from Table 8, receiving a doctoral degree from the top-20 schools are positively correlated with the academic research performance. Both on quantity and quality aspects (columns 1 and 2, respectively in Table 8), the effect of most elite schools is large – even larger than simple "foreign Ph.D. share" in the previous estimation - and significant at 1%. One standard deviation shift in top-20 school share leads to an almost 25% change in average paper values, whereas it results in 13% change in average impact factors. Even more importantly, obtaining a foreign degree from a

[17] http://www.arwu.org/FieldENG2009.jsp

university *outside* the first twenty in global rankings does not affect research performance neither in quantity nor in quality.

Table 8 Regression results: specification of school quality

	Avg. Publication per Scholar	Avg. Impact Factor
Top 20 School Share	**1.588****	**1.746****
	(3.230)	(2.774)
Top 20-50 School Share	0.143	-0.739
	(0.130)	(-0.528)
Top 50-100 School Share	-0.797	-0.639
	(-0.632)	(-0.396)
Avg. Student	**-0.010****	-0.001
	(-3.229)	(-0.333)
Avg. Grad Student	0.030	0.007
	(1.207)	(0.212)
Avg. Career Age	0.121	**0.272**
	(1.133)	(1.993)
Avg. Career Age Sq.	-0.006	-0.010
	(-1.332)	(-1.737)
University Age	0.002	-0.005
	(0.621)	(-1.049)
Constant	0.225	-0.148
	(0.364)	(-0.186)
R-squared	0.483	0.363

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. t-statistics in parentheses.
Statistically significant coefficients are marked **bold.**

As their t-values verify, the effect of foreign Ph.D. shares in Turkish universities from organizations between the rankings of 20-50, and 50-100 are insignificant. We consider this result as a very striking fact which underscores the importance of the institutional quality on publication productivity.

In light of this result, brain drain actually becomes beneficial (beneficial brain drain) - in our context – *through* scholars who have received their degrees from one of the universities in the top-quality schools. A Ph.D. obtained from rest of the foreign universities appears to have no additional positive effect on academic research, relative to degrees obtained domestically. This fact may have various implications in terms of the economic aspects of brain migration, educational policies and alike.

Lastly, results from rest of the control variables remain to be more or less the same in the second regression. The effect of average number of undergraduate students on quantity appears to be very robust with the negative sign still present, whereas average years passed since Ph.D. has positive but diminishing correlation with publication quality, with

significance at almost 5% (t-value 1.993)[18]. Average number of graduate students and university age are found to have no effect on academic research in either aspect.

4.1.3 Further Specifications

University Type

Over the last two decades or so, higher educational system in Turkey has been exposed to a major transformation. The introduction of private universities has drawn large attention and it encountered both approvals and criticisms in many grounds. The discussion of these competing ideas is beyond the scope of this paper. Yet, while private universities differ in various aspects such as instructor quality, technological equipment or – rather questionably – a more free environment for academic research, it is safe to assert that the conventional belief in Turkey is that at least some of the mostly known private universities are far more better than most of the long-standing existing public organizations.

In this light, we have employed a further specification involving the university type. Since three private universities – Bilkent, Sabancı and Koç University – have come up in the first three places in rankings of having foreign Ph.D.'s, our expectations were that such a specification would lead to a change in our results. It indeed might have been the case that the presence of enhanced opportunities that the private universities offer is in fact the major determinant of the academic research performance, rather than the foreign Ph.D.'s. Likewise, it may be the case that foreign Ph.D.'s prefer to work in private universities.

To capture university type, we created dummy variables for private universities in our regression. We then executed our previous regression with this additional dummy variable. At this point, we turn to our results to see whether this sort of a differentiation in university types leads to having an impact on academic research.

This regression, as depicted in Table 9, yields an interesting result. We observe that the differentiation between university types is *not* correlated to academic research. To put it in other words, while presumably having more state-of-art equipments, funds and encouragement for research, scholars from private universities cease to show any better outcomes neither in *average publication per scholar* nor in *average impact factor*, than their colleagues in public universities. In addition, the coefficient of the first variable – top-20

[18] The corresponding value for P > |t| is 0.054.

school share – remains to be large and significant at 1% level. So, even after controlling for university type, the effect of top-20 Ph.D. granting schools on research productivity remains positive and statistically significant.

Table 9 Regression results: university type and departmental compositions

	Avg. Publication per Scholar	Avg. Impact Factor
Top-20 School Share	**1.592****	**1.611***
	(2.970)	(2.352)
Top 20-50 School Share	-0.333	-0.697
	(-0.287)	(-0.471)
Top 50-100 School Share	-1.425	-0.986
	(-0.943)	(-0.511)
Avg. Student	**-0.015****	0.000
	(-3.539)	(0.068)
Avg. Grad Student	0.033	0.004
	(1.242)	(0.129)
Avg. Career Age	0.127	**0.262**
	(1.100)	**(1.772)**
Avg. Career Age Sq.	-0.006	-0.009
	(-1.312)	(-1.548)
University Age	0.003	-0.004
	(0.650)	(-0.882)
Chemical Eng. Share	-0.582	0.068
	(-0.828)	(0.075)
Environmental Eng. Share	-0.647	-0.560
	(-1.055)	(-0.715)
Mechanical Eng. Share	**-1.361**	0.310
	(-1.693)	(0.302)
Industrial Eng. Share	-0.477	-0.728
	(-0.725)	(-0.866)
University = Public	-0.111	0.107
	(-0.574)	(0.431)
Constant	1.108	-0.034
	(1.320)	(-0.031)
R-squared	0.552	0.450

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. t-statistics in parentheses.
Statistically significant coefficients are marked **bold**.

Type of university that a scholar works for, it is thus observed, is not associated to an additional impact on academic activity of the scholar, given that she had obtained her doctoral degree from one of the top-quality schools. Since our estimations are on university basis, another possible interpretation is as follows: Given two universities with equal top-20 school Ph.D. shares, their type – either private or public – does not cause any difference in academic research relative to the other.

Departmental Compositions

Since our focus is on universities and we conducted regressions on that level, our previous estimations did not take into account the differences in department compositions. For example, a university with a very large Environmental Engineering department may have higher per capita publication since scholars in this discipline tend to publish more. To overcome this issue, we calculated shares of total scholars from each department in a given university, which would in total sum up to 100%. We reduced the number of fourteen different fields to five; since our observation count is only forty-three and having fourteen additional independent variables would lead to a significant loss in degrees of freedom and explanatory power in our regression. We did the aggregation by merging close fields. Furthermore, we used electrical engineering, the most common department across universities, as a basis and omitted it in our regressions.

The results are depicted in Table 9. We observe that with a t-value of 1.693, mechanical engineering departments have a *negative* contribution to publication quantities at almost 10% significance level.[19] Increasing the mechanical engineering share by 1 percentage point in an engineering faculty (which, in turn, would lead to a same amount of decrease in other departments in total) would result in a decrease in average publication counts for a given university. Thus, this estimation allows us to interpret that mechanical engineering departments are significantly less productive in academic research relative to electrical engineering.

In sum, what emerges to have more importance is that the positive contribution of top-quality school graduates to academic research, as captured by the *top-20 school share* variable, still remains to be large and statistically significant, even after controlling for both the university type and the compositional differences in sub-fields of engineering in Turkish universities. A larger share of scholars from universities with a ranking in the first twenty appears to have a strong correlation with research productivity both on quantity and quality aspects.

[19] The corresponding value for P > |t| is 0.101.

4.1.4 Spillover Effect on Domestic Ph.D.'s

Even though there exists a sharp increase in the amount of students who obtain their doctoral degrees abroad in the last two decades, it is obvious that the majority of scholars in the engineering faculties of Turkish universities are still of domestic educational origin. As described in section 2, around two-thirds of the current academic staff in engineering faculties has obtained higher education in one of the organizations in Turkey. With this regard, this paper also aims to explore the possibility of a so-called *spillover effect* of Foreign Ph.D.'s on the publication performance of academic staff with a degree from Turkey.

We investigate whether the presence of Foreign Ph.D.'s in an academic environment has an indirect effect on research conducted by scholars without a foreign degree. Such an argument is strongly related to one of the views in the existing literature on beneficial brain drain which states that such beneficial outcomes are possible if a transfer of knowledge occurs from the migrants to others upon return to their home country. In the context of this paper, we believe that such a transfer may be proven by the publications of domestic Ph.D.'s with the presence of their colleagues with a foreign degree who presumably have higher expertise in academic research.

In order to achieve this goal of analyzing such an indirect effect, we restrict our sample to scholars with a domestic degree while holding all explanatory variables same. Consequently, we make the regression with this sample, and the results are presented in Table 10. To avoid repetition, we prefer to present the results for the regression with all of the control variables at once and skip the step-by-step process, which we had done in previous subsections.

Results of this final regression show that a spillover effect on domestic Ph.D.'s is indeed present in Turkish engineering faculties. Top-20 School share, for instance, has a positive correlation with *average publication per scholar* with 1% significance level. So, it can be asserted that foreign Ph.D.'s help their colleagues to engage in more academic research. This increase may be caused directly - through publications with co-authorship. A higher foreign Ph.D. ratio in a faculty may generate more incentives for domestic Ph.D.'s to work with their colleagues with their presumed higher skills in research.

Table 10 Regression results: Domestic Ph.D.'s only

	Avg. Publication per Scholar (Only Domestic Ph.D.)	Avg. Impact Factor (Only Domestic Ph.D.)
Top 20 School Share	**1.971****	**6.399*****
	(3.515)	(6.048)
Top 20-50 School Share	0.673	**-5.244***
	(0.555)	(-2.296)
Top 50-100 School Share	-0.435	-1.885
	(-0.275)	(-0.632)
Avg. Student	**-0.013****	0.006
	(-3.002)	(0.688)
Avg. Grad Student	0.011	0.029
	(0.383)	(0.559)
Avg. Career Age	0.050	0.429
	(0.416)	(1.876)
Avg. Career Age Sq.	-0.003	-0.016
	(-0.677)	(-1.735)
University Age	0.003	-0.006
	(0.737)	(-0.731)
Environmental Eng. Share	-0.514	0.354
	(-0.802)	(0.293)
Industrial Eng. Share	-0.456	0.384
	(-0.663)	(0.296)
Mechanical Eng. Share	-1.084	1.521
	(-1.288)	(0.958)
Chemical Eng. Share	-0.003	1.426
	(-0.005)	(1.027)
Type = Public	0.113	0.018
	(0.559)	(0.048)
Constant	1.130	-2.048
	(1.287)	(-1.236)
R-squared	0.615	0.696

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. t-statistics in parentheses.
Statistically significant coefficients are marked **bold.**

Additionally, the increase may have resulted from a rather indirect effect. It may be the case that the presence of scholars with a degree from top-quality schools of the world creates an environment in which a transfer of knowledge and expertise occurs. Consequently, domestic Ph.D.'s can benefit from such an interchange which results in higher number of publications. Also, assuming that the scholars from top-20 schools are likely to produce in high amounts on their own, another case could be that other scholars in the faculty are likely to start keeping up with the competition by producing more. Lastly, it is possible that there results are subject to some selection effects. Domestic Ph.D.'s from relatively better Turkish universities may have preferred to work where scholars from top-20 schools are currently

employed. They may have chosen to find employment in universities with higher top-20 school shares, which may be the underlying factor for the results in our final regression showing that there exists a significant effect of top-quality school shares on domestic Ph.D. productivity.

On the quality aspect of research, the positive effect of top-20 school shares seems exceptionally large with the coefficient of 6.399. Seemingly, the presence of scholars with degrees from top-quality schools contributes very strongly to the publication qualities of others. Domestic Ph.D.'s on average start publishing in significantly higher quality journals upon receiving either incentives or expertise to conduct academic research from their co-workers.

On the other hand, the estimations in this final regression also yield an interesting (or even surprising) result: The top 20-50 share in a university - which means the ratio of scholars that have obtained their degrees from one of the universities between the 20^{th} and 50^{th} rankings - is *negatively* correlated with the publication quality of scholars with domestic degrees. With a t-value of 2.296, the negative effect on *average impact factor* is statistically significant at 5% level. This is somewhat an unexpected result and one possible explanation could be as follows: Scholars from this type of schools may be using the greater part of the available resources such as technological equipments or research assistants in a university, which turns out to be very detrimental for the domestic Ph.D.'s who certainly need their fair share of resources in order to conduct research.

In sum, it comes into sight that there exists a positive spillover effect of foreign Ph.D.'s from the top-quality schools on scholars who had not left their country but rather obtained their degrees domestically. Transfer of knowledge from the returned migrants to their colleagues in engineering faculties appears to have realized and it provides better outcomes in terms of academic research among Turkish universities. While the relation with publication quantities is notable, the impact on the quality aspect is also very remarkable.

5 Conclusion

In this paper, we studied the consequences of the infamous Brain Drain in Turkey in graduate education context. Following the recent literature which centers on the positive outcomes of the emigration of skilled personnel from a developing country, we investigated the possibility of a Beneficial Brain Drain through academic scholars which have obtained their doctoral degrees abroad and returned to Turkey upon completion of their study.

With a rich dataset, we first presented a detailed overview of the current Ph.D. Market in the engineering faculties of Turkish universities. A descriptive analysis of this sort had not been performed before and we believe that our study fills an important gap in explaining the characteristics of the Turkish academia. Then, we conducted regression analyses to explore the determinants of academic research in Turkey. Our main focus, which directly links our work to the literatures of both Brain Drain and research productivity, was the contribution of foreign Ph.D.'s to academic research conducted within Turkish higher education institutions. Moreover, we controlled for several factors such as career ages, teaching loads of scholars, as well as university specific information including university age, type and departmental compositions.

Our descriptive analysis showed that, as of the academic year 2009-2010, one-third of Ph.D.'s in our sample have obtained their doctoral degrees from a foreign university. U.S.A is by far the most preferred country for pursuing higher education. We also found that the number of foreign Ph.D.'s in Turkey witnessed a steady rise in the last two decades and tripled from 1990 to 2000.

At university level, we showed that the foreign Ph.D. shares in Turkish universities contains large variations: the mostly-acclaimed private universities widely attract foreign Ph.D.'s with around 85% of their academic staff consisting of scholars with a degree from abroad, whereas at the bottom level there are some long-established public organizations which have as low as 10% of their academic staff with foreign Ph.D.'s. For the domestic Ph.D. characteristics of Turkish academia in engineering, we observed that three major technical universities are leading in granting doctoral degrees to Turkish students.

On the academic research, we presented a descriptive overview of the productivity of engineering faculties at Turkish universities in the year 2008. In this light, we provided a ranking of forty-three Turkish universities in publication counts which included a wide range from around 1.75 to almost 0.20 *publications per scholar*. We also introduced a classification

of universities with respect to the quality aspect of academic research by using the *average impact factors* of journals. An analysis with respect to sub-fields of engineering on department levels was also presented. Lastly, our dataset allowed us to assert the productivity of Turkish scholars in engineering faculties over years. Although the amount of publications in the year 2008 was largely done by scholars with around 10 years of experience; after controlling for the scale differences with respect to age groups in our dataset, we found that Turkish scholars do not show a declining fashion in academic performance over the course of their careers.

Regarding the estimations on analyzing the determinants of research productivity in Turkish universities, our prior reasoning and expectations were confirmed. We found that the presence of foreign Ph.D.'s indeed has a positive impact on academic research productivity. Moreover, this positive contribution is only realized through scholars with a degree from the top-quality schools that are ranked in the first twenty in global rankings. Restricting our sample to domestic Ph.D.'s, we also found that at university level, a *spillover effect* of foreign education exists on scholars which have obtained their degrees in Turkey. The percentage of scholars with a degree from a top-quality school is positively correlated to the research conducted by domestic Ph.D.'s both on quantity and quality aspects.

For the other factors that were controlled, we found that teaching load is negatively correlated with academic research quantity, whereas career ages of scholars have positive but diminishing impact on quality. Interestingly, the distinction between university types revealed that private universities on average did *not* perform better than public universities in academic research in 2008. In the end, the contribution of top-quality foreign schools to the research productivity in engineering faculties of Turkey still remained positive, large and statistically significant.

Although we avoided stating strong causalities since there may be many other related factors in an area of this magnitude, we concluded that a Beneficial Brain Drain – either on individual terms or via a transfer of knowledge or incentives to others - is possible when Turkish students receive doctoral degrees not only from a foreign university but from an elite one. We believe that this finding has some implications regarding the economical aspects of brain migration, educational policies and alike in Turkey.

For future research in our work, several improvements come to mind. First and foremost, the existing dataset can be expanded with a multi-year time dimension. Information on publications of Turkish scholars over the course of their whole careers would certainly yield a better insight on the characteristics of academic research conducted in Turkey.

Second, a specification on domestic Ph.D. quality can be implemented. This way, the quality of graduate education in Ph.D. granting Turkish universities and consequently the expertise and skills of scholars with a domestic degree can be differentiated. Such a ranking among domestic institutions can be used as a further control in the estimations.

Finally, micro-level data on salaries, rewards and grants of Turkish scholars as well as their genders and information on their past education such as university-entrance test scores or undergraduate GPA's can be of great use. Such figures would both enhance the explanatory power of the regressions in our setting and provide an opportunity to make the estimations on individual level more accurately.

References

[1] Beine, M., F. Docquier and H. Rapoport (2001), ”Brain Drain and Economic Growth: Theory and Evidence”, *Journal of Development Economics*, 64, 1: 275-89.

[2] Bhagwati, J.N. and Hamada, K. (1974). ‘The brain drain, international integration of markets for professionals and unemployment: A theoretical analysis.’ *Journal of Development Economics*, vol. 1, no. 1, pp. 19-42.

[3] Cinar, D. and F. Docquier (2004), ”Brain drain and remittances: consequences for the source countries, Brussels Economic Review”, 47(1), Special issue on skilled migration, 103-118.

[4] Cox Edwards, A. and M. Ureta (2003), ”International migration, remittances and schooling: evidence from El Salvador”, Journal of Development Economics, 72, 2: 429-61.

[5] Diamond, A. M. (1986). The Life-Cycle Research Productivity of Mathematicians and Scientists. *Journal of Gerontology*, 41, 520-525.

[6] Docquier, Frédéric, Brain Drain and Inequality Across Nations (November 2006). IZA Discussion Paper No. 2440.

[7] Domingues Dos Santos, Manon and Fabien Postel-Vinay (2003): Migration as a source of growth: the perspective of a developing country, *Journal of Population Economics*,16,1: 61-75.

[8] Dustmann, Christian and Kirchkamp, Oliver, The Optimal Migration Duration and Activity Choice After Re-migration (February 2001). IZA Discussion Paper No. 266.

[9] Fabel, O., M. Hein and R. Hofmeister (2008), ‘Research Productivity in Business Economics: An Investigation of Austrian, German and Swiss Universities’, *German Economic Review*, 9 (4), 506-531.

[10] Gonzalez-Brambila, C. and Veloso, F. (2007), “The determinants of research output and impact: A study of Mexican researchers”, *Research Policy*, Vol. 36, p. 1035–1051.

[11] Guimarães, P. (2002), ‘The State of Portuguese Research in Economics: An Analysis based on Publications in International Journals’, *Portuguese Economic Journal* 1, 3–25.

[12] Güngör, N. D. and Tansel, A. (2008a) “Brain Drain from Turkey: An Investigation of Students’ Return Intentions.” *Applied Economics* 40: 3069-3087.

[13] Haque, N. U and S. Kim (1995), ”Human capital flight: impact of migration on income and growth”, IMF Staff Papers 42(3), 577-607.

[14] Jacob, B. and L. Lefgren (2007), ‘The Impact of Research Grant Funding on Scientific Productivity’, NBER Working Paper No. 13519.

[15] Kırdar, Murat G., "Determinants of Return Migration of Turkish Immigrants in Germany", in *the Proceedings of the International Conference on Middle East and North African Economics*, Editors: Ali Bayar and Jeffrey Nugent, June 2-4 2005, Brussels/Belgium.

[16] Kocher, M. G. and M. Sutter (2001), 'The Institutional Concentration of Authors in Top Journals of Economics during the Last Two Decades', *Economic Journal* 111, 405–421.

[17] Kwok, V. and Leland, H.E. (1982). "An economic model of the brain drain." *American Economic Review*, vol. 72, no. 1, pp. 91-100.

[18] Levin, S. & Stephan, P. (1991). "Research Productivity Over the Life Cycle: Evidence for Academic Scientists." *The American Economic Review*, 81, 114-132.

[19] Lucas, R.E., 1988. "On the mechanics of economic development." Journal *of Monetary Economics* 22(3)., 3–42.

[20] Maske, K. L., G. C. Durden and P. E. Gaynor (2003), "Determinants of Scholarly Productivity among Male and Female Economists", *Economic Inquiry* 41, 555–564.

[21] Miyagiwa, K. (1991), "Scale economies in education and the brain drain problem", *International Economic Review*, 32, 3: 743-59.

[22] Mountford, A. (1997), "Can a brain drain be good for growth in the source economy?", Journal of Development Economics, 53, 2: 287-303.

[23] Pieper, Paul J. and Willis, Rachel A. , "The Doctoral Origins of Economics Faculty and the Education of New Economics Doctorates", *Journal of Economic Education*. Winter 1999, pp. 80-89.

[24] Rauber, Michael and Ursprung, Heinrich W., 2008, "Life Cycle and Cohort Productivity in Economic Research: The Case of Germany" *German Economic Review*, Blackwell Publishing, vol. 9, pages 431-456, November.

[25] Stephan, Paula E. ,"The Economics of Science" *Journal of Economic Literature,* Vol XXXIV, September 1996, pp. 1199-1235.

[26] Taylor, S. W., B. F. Fender and K. G. Burke (2006), "Unraveling the Academic Productivity of Economists: The Opportunity Costs of Teaching and Service", *Southern Economic Journal* 72, 846–859.

[27]Vidal, J.P. (1998): "The effect of emigration on human capital formation", *Journal of Population Economics*, 11, 4: 589-600.

[28] Wooldridge, J. M. (2002), Econometric Analysis of Cross Section and Panel Data, MIT Press, Cambridge, MA.